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AN APPLICATION OF TACTICAL ENGAGEMENT SIMULATION FOR UNIT PROFICIENCY MEASUREMENT

11 Jul 79

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The need for methods of measuring team and unit proficiency, and the lack of knowledge in this area are widely recognized. Team performance measurement difficulties are fundamental problems in unit proficiency diagnosis and training evaluation, in both military and civilian settings. Existing Army combat unit performance measurement techniques depend largely on judgmental data. over

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A tactical training system, called tactical engagement simulation (ES), uses objective, accurate casualty assessment that offers a potential means of measuring team performance in combat training. Objective casualty assessment provides the primary measures of team proficiency, such as casualty exchange ratios and mission accomplishment.

This report reviews application of ES to unit measurement, with emphasis on lessons learned while validating ES procedures for armor units and while developing ES for armored cavalry units.

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Tactical Skill Acquisition & Retention

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FOREWORD

Learning tactical skills on the battlefield is costly; learning tactical skills short of a real combat environment is difficult. Yet this is precisely the Army's training mission--training troops in tactical skills and constantly improving the effectiveness and efficiency of that training.

In 1971 the Army Research Institute for the Behavioral and Social Sciences (ARI) with the Army's Training and Doctrine Command (TRADOC) initiated research which led to development of a tactical training method now known as tactical engagement simulation training (ES). Two tactical engagement simulation training techniques have been implemented Army-wide: SCOPES (Squad Combat Operations Exercises Simulation) for infantry squad training and REALTRAIN for armor, antiarmor, and combined arms training.

Engagement simulation training was designed to require the same tactical behaviors as does actual combat. The REALTRAIN model is based on a number of learning principles that have been demonstrated to be important for effective training. Probably most important is that the competitive nature of REALTRAIN exercises provides motivation to learn, an element often lacking in Army training.

The potential of engagement simulation training has been demonstrated. For this potential to be realized fully, further research has been required to refine current engagement simulation training techniques to make them more effective and to extend these techniques to other applications. This report describes the use of tactical engagement simulation for the measurement of unit proficiency, with emphasis on the objective, rather than subjective, performance assessments that can be made using ES.

This research was part of a larger research program which is responsive to the requirements of Army Project 2Q763743A773 and the TRADOC System Manager for Tactical Engagement Simulation of the U.S. Army Training Support Center, Fort Eustis, Va.

Joseph Zeidner

JOSEPH ZEIDNER
Technical Director

AN APPLICATION OF TACTICAL ENGAGEMENT SIMULATION FOR UNIT PROFICIENCY MEASUREMENT

BRIEF

Requirement:

To develop techniques for objectively measuring the combat proficiency of Army units and teams.

Product:

The training system called tactical engagement simulation (ES) also assesses the training results objectively, using casualty exchange ratios and mission accomplishment data as "product measures." Armor-antiarmor exercises, for instance, use records of casualties, time, and mission accomplishment to measure the total skills of the units. ES training and assessment procedures have been developed for infantry and armor-antiarmor units and are under development for other types of unit and mission.

"Process measures" to assess performance and skills during a mission are also necessary, to help diagnose problems and explain product data, and to assess noncasualty-producing missions. For instance, the performance of armored cavalry, whose primary mission is reconnaissance and security, must be judged entirely by process measures. The records and observations of process measurement also provide a way to note and evaluate external factors such as weather that affect the mission.

Utilization:

Difficulties in measuring team performance using existing judgmental techniques have been a fundamental problem in diagnosing proficiency. ES measures may aid the situation greatly.

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AN APPLICATION OF TACTICAL ENGAGEMENT SIMULATION FOR
UNIT PROFICIENCY MEASUREMENT

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AN APPLICATION OF TACTICAL ENGAGEMENT SIMULATION FOR UNIT PROFICIENCY MEASUREMENT

INTRODUCTION

The need for methods of measuring team and unit proficiency and the lack of knowledge in this area are widely recognized. Difficulties in measuring team performance are fundamental problems in unit proficiency diagnosis and training evaluation in both military and civilian settings (Blum & Naylor, 1968; Defense Science Board, 1975). Existing combat unit performance measurement techniques depend largely on judgmental data and often do not evaluate the unit's ability in the field (Hayes et al., 1977). Researchers must solve these measurement problems before they can substantially improve unit training.

A tactical training system, called engagement simulation (ES), uses objective, accurate casualty assessment that offers a potential means of measuring team performance in combat training. Objective casualty assessment provides the primary measures of team proficiency, such as casualty exchange ratios and mission accomplishment. Recent advances in ES procedures have further improved its uses for assessing tactical performance. This paper reviews application of ES to unit measurement, with emphasis on lessons learned while validating ES procedures for armor units and developing ES for armored cavalry units.

ENGAGEMENT SIMULATION

ES techniques provide realistic tactical training under conditions that simulate the complex modern battlefield. In addition to casualty assessment, characteristics that contribute to the realism of ES are the use of two-sided, free-play tactical field exercises and simulation of weapons effects and signatures.

Objective casualty assessment is achieved when a soldier, looking through a 6X-power telescope mounted on his rifle, correctly reads a 3-inch, two-digit number on the helmet of an opposing unit member. The telescope power and helmet number size have been calibrated to produce hit/kill probabilities realistic for the weapon's lethality. When the soldier fires a blank cartridge and correctly identifies the opposing helmet number, a casualty is assessed. A controller with the fire team radios the helmet number to a controller with the opposing team, who informs the "hit" soldier (U.S. Army Infantry School, 1975).

Analogous objective casualty assessment, weapons effects, and signature simulation procedures have been established for infantry, armor, and antiarmor elements, including these weapons systems: M60 tank main gun; mines; hand grenades; machineguns; and light (LAW), medium (DRAGON), and heavy (TOW) antitank weapons. For longer range

weapons than the rifle, the controller is equipped with optics to sight individual helmet numbers and numbers on panels attached to vehicles. In the tank, for example, the controller's telescope is mounted in the breech of the main gun. When the controller in the tank determines that the gun is centered on a target at the time of simulated round impact, he assesses a casualty. The controller then radios the number of the hit to the controller with the opposing team.

The radio net over which controllers announce the casualties is used by senior controllers to administer the exercise and is monitored by personnel who record the hits. The monitors write the time, target number, and firer number on a net control sheet, and they check that the hit was confirmed by the controller in the target vehicle.

All ES systems provide some way of identifying casualties. The REALTRAIN system uses telescopes and numbers, a system that has been used for training with opposing forces as large as reinforced platoons. A Multiple Integrated Laser Engagement System (MILES) has been developed to achieve tactical realism in larger units. MILES uses low-power, eye-safe laser transmitters mounted on each weapon. Each target (vehicle or soldier) has solar cell detectors that receive the laser signal as either a hit or a near miss. Hits activate a buzzer on the target, which can be silenced by deactivating the target's laser transmitter. The lasers are pulse coded to differentiate weapons' effects (e.g., rifles can kill individuals but cannot destroy tanks). Use of the lasers reduces the need for human controllers but also reduces the amount of data available on tactical activities.

ES differs from some of the more common simulation techniques, such as board games and computer simulations, in that it is conducted in the field with a full complement of soldiers and equipment. Although ES uses tactical equipment, it emphasizes human behavior: It is man-ascendant rather than machine-ascendant. ES emphasizes tactical decisions--reactions to events that emerge during competition with a motivated, intelligent adversary. The cues to which soldiers must respond are similar to those to which they respond in battle, and the situation changes as a result of their actions. Thus, the situation is emergent rather than prespecified, highly predictable, or amenable to analytic solution (Boguslaw & Porter, 1966).

PERFORMANCE ASSESSMENT

The objective casualty assessment in ES provides some, but not all, of the necessary performance measures. Casualties (target, firer, and time) are the primary criteria, but relying solely on casualties makes it difficult to determine why they occurred. Additional observations or measures of active performance, are required when the final outcome is not an adequate index of skill (Cronbach, 1960). Measures of processes or intermediate task and training objective performance assist in training diagnosis and explanation of product data.

An example is the detection and engagement of the enemy at the maximum possible range during defensive missions. Particularly at company level and below, there is little recognition of the importance of observation posts to provide exact and timely information about the enemy. In exercises between relatively untrained units, most critical decisions and actions occur along the forward edge of the battle area. As the units become more sophisticated, leaders in the defensive unit spend more effort on selecting observation post positions, planning communications and indirect fire, and positioning long-range, direct-fire weapons. As a result, detection and effective engagement ranges increase.

Tactical outcomes depend upon several factors other than the proficiency of the units: interactions among force mix, missions, weather, and terrain can influence tactical results. For example, weather interacts with force mixes, since poor visibility favors dismounted troops to the disadvantage of long-range weapons. If visibility improves during the tactical action, then the advantage reverts to the long-range weapons. Because of such interactions, the outcome does not necessarily indicate the relative proficiency of the opposing forces. The impact of external factors must be considered in evaluating the results of an exercise.

Problems arise in both recording behavior (active performance or processes) and encoding the environment (such as the external factors). Thus, observational field research needs a system for detecting, measuring, and recording the events and the pertinent factors (Sells, 1966).

Literature on ratings and observational performance assessment techniques in criterion development offers suggestions for improving field measurement (Blum & Naylor, 1968; Goldstein, 1974; Guilford, 1954; Simon, 1969; Wherry, 1952). Observations and ratings of behavior can suffer from unreliability and inaccuracy due to a variety of error sources. First, the performance itself is variable, since people perform better at some times than at others. This is especially true in emergent situations, where a given behavior may not be required in a specific instance or may be altered to suit the situation. Second, detection or observation of behavior is unreliable. An observer may not detect a given behavior, and different observers may perceive and assess behavior differently. Third, the recording of behavior introduces error, depending on the type of record. For example, recording events as they occur reduces error by decreasing recall or memory effects. Despite these error sources, observations and other judgmental measures continue to be the most frequently used type for performance criteria (Blum & Naylor, 1968).

Improved measurement can be achieved when the researcher (a) specifies and defines as concretely as possible the behaviors to be observed, (b) requires data collection personnel to observe but not to judge the behavior, (c) trains the observers fully, and (d) requires observers to

record their observations immediately on clear, concise, easy-to-use forms. The following sections discuss how we applied these principles and used observational techniques in conjunction with objective measures.

OBJECTIVE MEASURES

The use of casualty, time, and mission accomplishment data is demonstrated by results from the validation of armor REALTRAIN (Scott et al., 1978). Teams composed of tanks, heavy antitank weapons (TOWs), and artillery forward observers were pretested against a similarly composed opposition force (OPFOR). Half of the tested teams then had a week of REALTRAIN training, while the others had conventional tactical field training. The teams were posttested against the OPFOR. Casualty data show that the teams were similar in pretest performance (each bar in Figure 1 represents 52 vehicles). Posttest data showed that REALTRAIN teams improved in terms of casualties inflicted on the OPFOR, whereas conventionally trained teams did not.

Temporal distributions of the casualties during an exercise provide additional insight into changes in tactical performance. When the cumulative percentage of tested unit casualties is plotted against the elapsed time, it appears that fewer casualties were sustained early in the exercises after REALTRAIN training, in contrast to heavy early losses before training (Figure 2). Conventionally trained units sustained heavy early casualties both before and after training. Time data, in association with other objective data such as casualties, can be used to measure what went on during an exercise and what may have led to successful (or unsuccessful) mission accomplishment.

Mission accomplishment results showed the same patterns of REALTRAIN effectiveness as did the casualties. To accomplish its attack mission, a unit had to clear an objective of OPFOR elements and occupy the objective. To accomplish its defense mission, it had to prevent the OPFOR from occupying the objective for 60 minutes. Figure 3 shows mission accomplishment data for both attack and defense missions; each bar represents eight exercises. REALTRAIN teams improved in their ability to accomplish missions successfully, whereas conventionally trained teams did not.

Other objective data, such as artillery fire planning and use, are also recorded. Personnel in the fire direction center complete an indirect-fire data form indicating the number of rounds fired, time distribution, and casualties inflicted. The example in Figure 4 shows that "jeep 28" was hit by six rounds early in the exercise, but that no other indirect fire missions for this team were effective in this exercise. Inclusion of these data further clarifies explanation of the overall results.

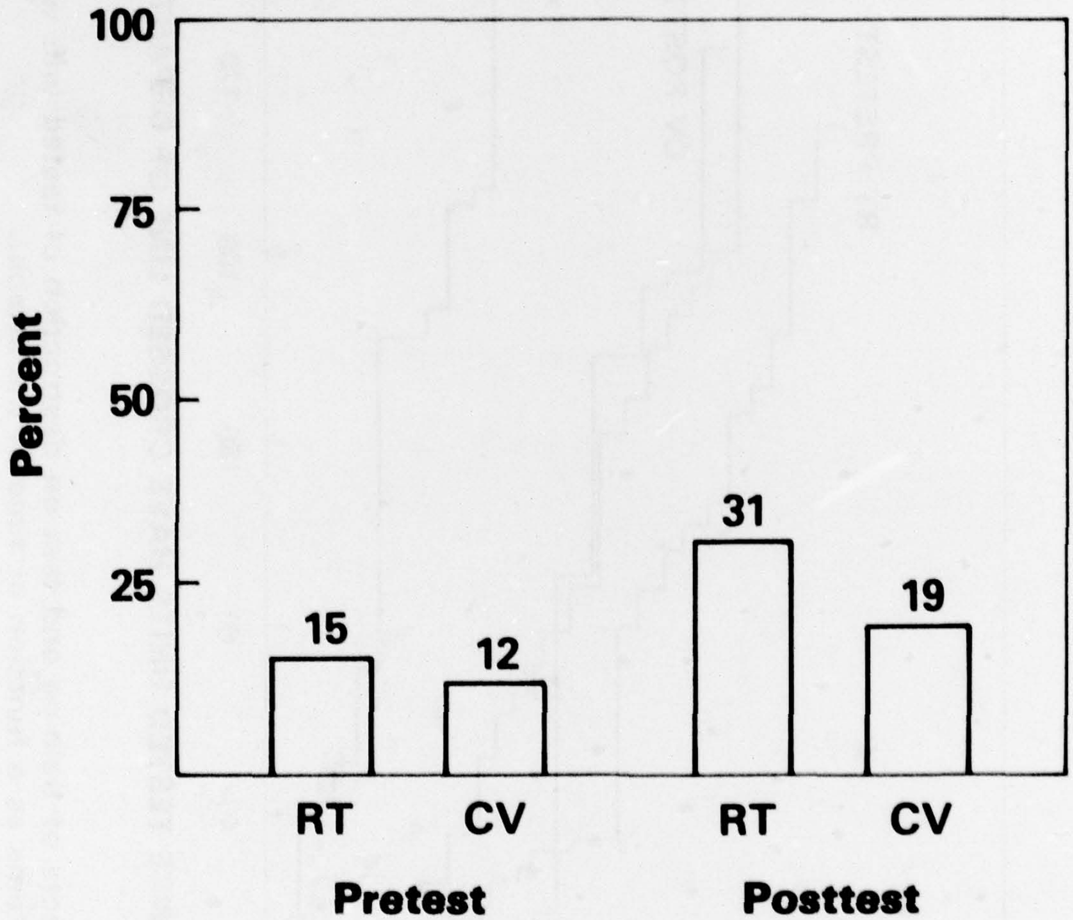

Figure 1. Percentage of OPFOR casualties: armor test.

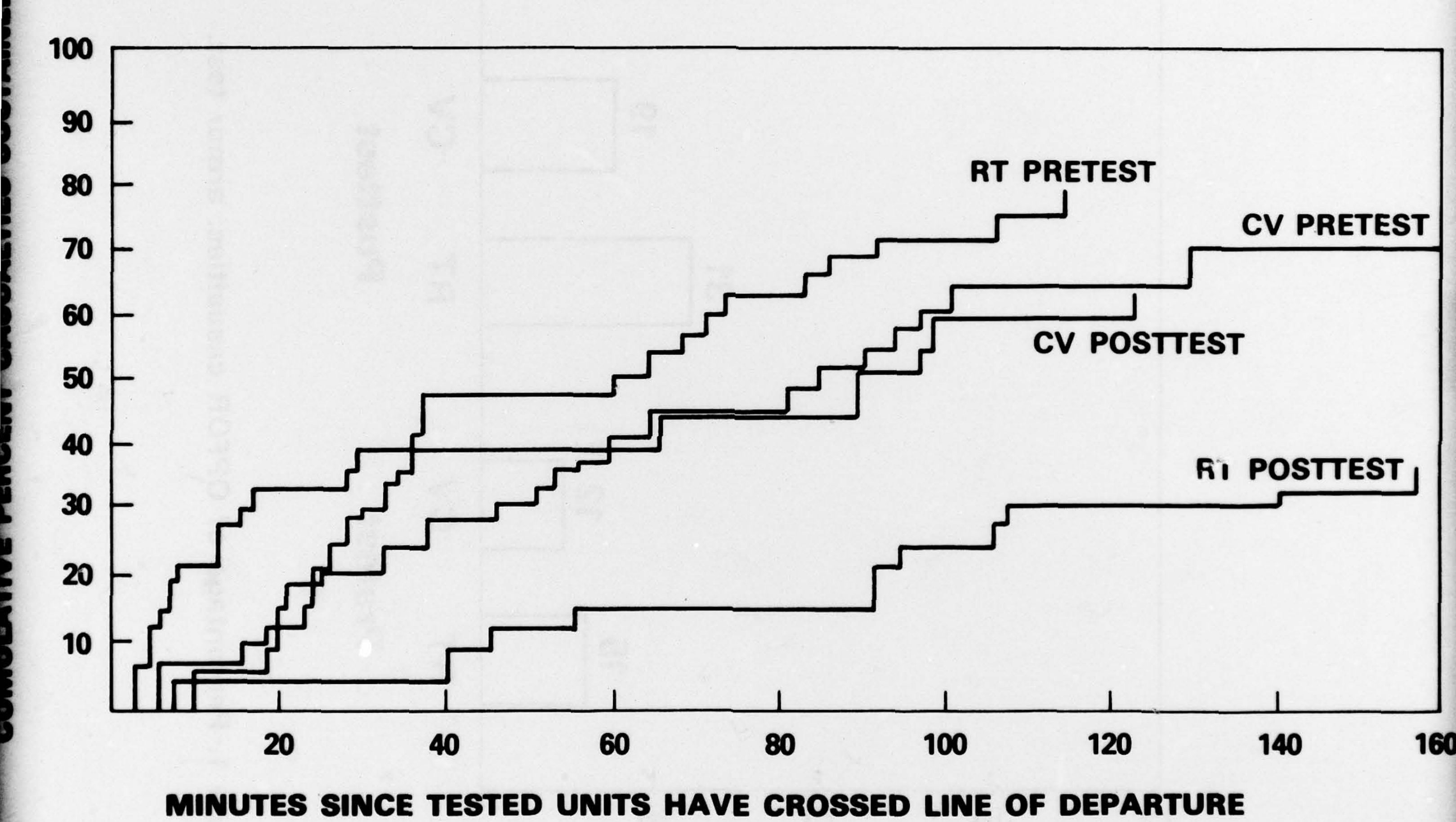

Figure 2. Effects of training and test on destruction of tested unit weapon systems as a function of time in the attack.

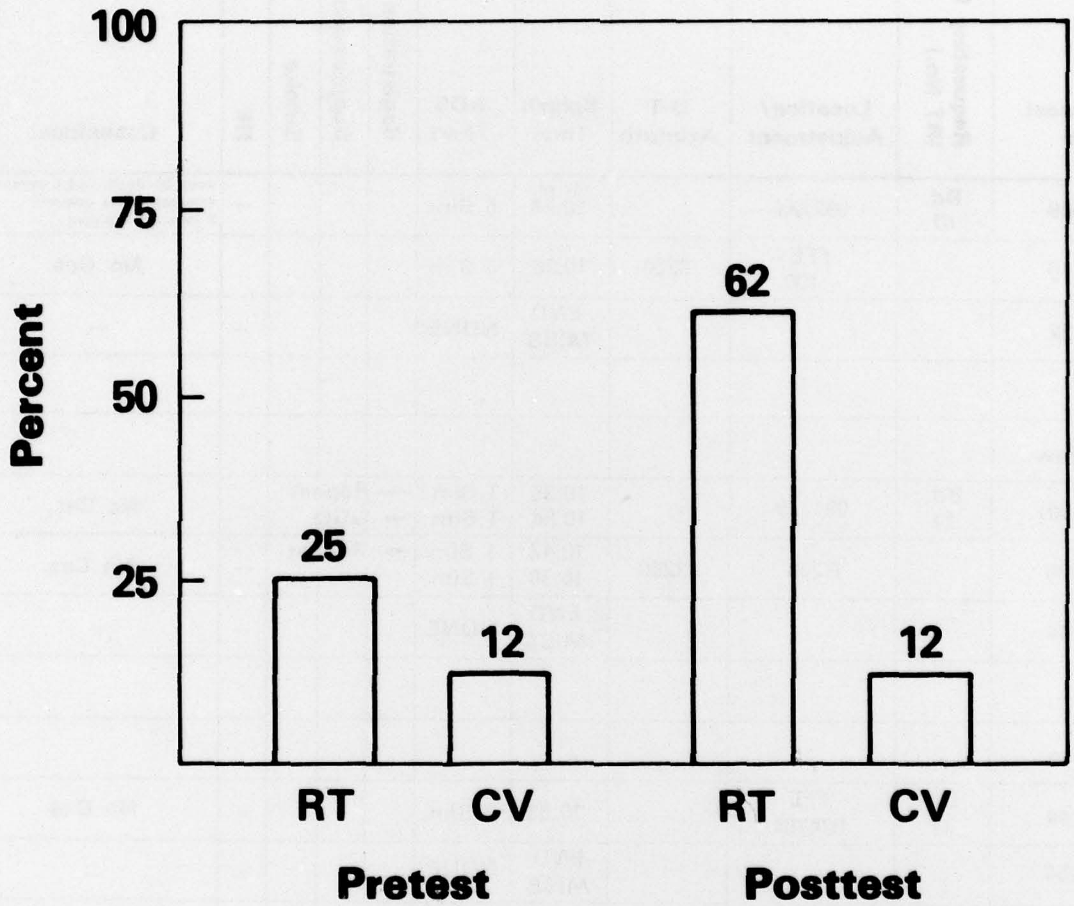

Figure 3. Percentage of successful missions: armor test.

PREPLANNED FIRES

Trial No.	CA #4	Test	X	101 1. 092723	5.
Date	24 MARCH 78	Training		102 2. 074704	6.
Unit I.D.	TEAM A	Shoot-Off		3.	7.
Name	SP/4 DOUGLAS	CAT		4.	8.

Request Time	Requesting I.D. (RT No.)	Location/ Adjustment	O-T Azimuth	Splash Time	RDS Fired	Registration	Suppression	Smoke	HE	Casualties
10:08	Bd. 47	092723		006 007 10:14	6 Sim				—	Jeep 28 destroyed 4 persons exposed TK-13 commc. 2 persons exposed
10:16		FFE −100	3200	012 10:20	6 Sim					No Cas.
10:22				END MISS	NONE				—	—
Yellow										
10:30	Bd. 47	091729		10:35 10:34	1 Sim 1 Sim	→ Repeat → DUD			—	No Cas.
10:36		R200	3200	10:42 10:38	1 Sim 1 Sim	→ Repeat			—	No Cas.
10:44				END MISS	NONE				—	—
Blue										
10:44	Bd 47	FFE 074704		10:53	6 Sim				—	No Cas.
10:54				END MISS	NONE				—	—
A	B	C	D	E	F	G	H	I	J	K

Figure 4. Indirect fire data form.

ARMORED CAVALRY ENGAGEMENT SIMULATION

Unlike other ES applications, armored cavalry ES cannot rely on casualties as performance data. "Cavalry's basic tasks are reconnaissance and security" (Department of the Army, 1977); cavalry may not produce casualties. The armored cavalry platoon gathers and reports information. When reconnaissance units withhold fire (e.g., to avoid disclosing their positions), tactical events may not lead to casualties. In developing ES procedures for cavalry units, the problem was to develop a realistic training environment for the reconnaissance functions, while maintaining the objectivity and credibility of the casualty-producing ES exercises. Thus, the cavalry ES research focused on process measures and external factors.

An armored cavalry ES training program was designed with aid from training personnel from the supporting unit of the 3d Armored Cavalry Regiment, Fort Bliss, Tex. Research results have been reported previously (Knerr, Hamill, & Severino, 1978; Knerr, Stein, Hamill, & Severino, 1978).

Only 2 weeks were available for the program, so it was not feasible to test all combinations of missions, force structures, and force ratios. The armored cavalry force was a regimental cavalry platoon containing scout, light armor, infantry, and mortar sections. The OPFOR was a combined arms team composed of tank, TOW, and infantry sections, with simulated indirect-fire support. For each mission, the OPFOR composition was varied to enhance realism and provide reasonable opposition. The missions selected were reconnaissance (area, route, and zone) and delay (Table 1).

Table 1

Platoon Missions by Exercise

Exercise	Cavalry platoon mission	OPFOR platoon mission
1	Zone reconnaissance	Delay
2	Route reconnaissance	Screen
3	Flank guard	Route reconnaissance
4	Area reconnaissance	Delay
5	Route reconnaissance	Attack
6	Delay/defend in sector	Zone reconnaissance

In these exercises, weather and terrain had strong effects on mission accomplishment. The weather was clear and sunny, providing optimal visibility. The terrain was flat desert, although there were sand dunes that could hide vehicles and soldiers. Moving vehicles were quickly detected by exhaust smoke and dust clouds from the tracks. The force assigned an attack mission or any moving mission was at a disadvantage under these conditions.

Relative combat power interacted with other external factors. Results of an attack with a 3:1 force ratio differ from results with 6 to 1 odds. If the opposing force is too strong or too weak, differences between the units may not emerge because of "ceiling" effects. During the first 2 days, the cavalry had reconnaissance missions and the OPFOR had a strong composition (main battle tanks, TOW, and infantry). After being hit hard on the first day, the cavalry moved so slowly on the second day that it made little progress. It did send reports of enemy strength to the commander, and it did not move forward in a "suicide" mission against the heavy, long-range weapons it detected. On subsequent days, the OPFOR was reduced in size, and the cavalry was given missions more suitable for reconnaissance activity.

External factors (missions, terrain, weather, force mix) must be considered in interpreting mission outcomes as measures of unit proficiency in tactical situations. Figure 5 shows the outline of a data form used to describe the exercise. The record starts with a description of the exercise lane (usually augmented by a map or sketch), weather, general tactical situation, missions, force structures, and other external factors. Next are notes of the platoon leaders' plans and orders to the vehicle commanders. Complete notes of the tactical activities are then recorded, along with the mission outcomes. These notes on plans, orders, and tactical activities provide an overview of processes (i.e., active performance) occurring during the exercise.

Location	
Terrain description	
Date	Exercise number
Green team	Brown team
Elements	Elements
Mission	Mission
Plan	Plan
Outcome	
Discussion	

Figure 5. Exercise narrative.

PROCESS MEASURES

Process measurement in the armored cavalry ES development was based on the principles described earlier for the improvement of observational measurement: train observers, specify the behavior to be observed as precisely as possible, and record during the action. Observers received initial training during 3 days of small-scale exercises that preceded the full-scale platoon exercises. These small exercises also familiarized the observers with the terrain, equipment, maneuvers, and data collection forms. Observers were thoroughly briefed each day on the exercise scenario, operations orders, and anticipated tactical events.

In the first exercise, the cavalry platoon had a zone reconnaissance mission. To clarify the behavior to be observed and recorded, more detail was needed than is given in the cavalry Army Training and Evaluation Program (ARTEP) (Figure 6; Department of the Army, 1976). To perform effectively, the commander needed to know the location and status of friendly forces and the location and strengths of enemy forces. The reconnaissance elements had to learn the importance of detecting the enemy at the maximum possible range and reporting the information to the commander. For example, they had to provide exact and timely reports on enemy activity to use indirect fire effectively.

To support these training objectives, the operations orders for the first exercise assigned the cavalry platoon a zone reconnaissance mission that directed the platoon to provide early warning, occupy an objective by a given time, and prepare to defend. Their assignment provided specific elements of intelligence and coordinating instructions. Essential elements of intelligence included enemy left in the area, enemy strong points, and enemy ability to move forward. In the coordinating instructions, the unit was told to hold at phase lines and request permission to cross, and to bypass pockets of resistance. They were under weapons-hold status, in which they could fire only with permission of the commander. Thus, the general requirements in the ARTEP mission were stated more specifically, and observable activities were defined.

The general situation described in the operations orders was realistic for a weapons-hold situation. As a result of this status, the vehicle commanders frequently reported enemy information, along with repeated requests for release from weapons-hold status and consequent permission to fire. They used their reports to build a convincing requirement to fire. The weapons-hold status, applied in the highly motivating ES environment, appeared to elicit concentrated reconnaissance reporting.

Establishing the reporting requirements and reinforcing them using the weapons-hold status, made tactical communications a valuable data collection vehicle. The reports contained time and location information for both friendly and enemy elements. The quality of the data was a problem, in terms of both accuracy and completeness, because of radio

Training and Evaluation

Unit: Armored Cavalry Troop
Mission: 1-7. Zone Reconnaissance

Task	Conditions	Training/evaluation standards	Rating S	Rating U	Rating Remarks
		Elements conduct movement according to troop commander's task-organization. Elements maintain OPSEC (see mission 0-15).			
1-7-6. Cross LD.	Troop commander designates the LD passage points, latest time to return through friendly lines, and other control measures in OPORD.	Elements cross LD on time. Elements cross LD at designated passage points in specified task organization and begin zone recon.			
1-7-7. Reconnoiter designated zone.	Troop commander specifies task organization, command control, and boundaries in OPORD.	Recon elements report on Threat forces, key terrain and routes timely and within specified tolerances. Elements conduct zone reconnaissance using proper movement techniques (FM 17-95). Elements thoroughly search for Threat forces throughout zone.			

Figure 6. Army Training and Evaluation Program for armored cavalry (adapted from ARTEP 17-55).

Task	Conditions	Training/evaluation standards	Rating		
			S	U	Remarks
1-7-8. Make contact.	Threat force engages elements of troop.	Overwatch elements lay down suppressive fire and request indirect fire support. Bounding elements deploy to cover and return fire. Elements observe and report. Report includes type and number of vehicles in Threat force within 80% accuracy. Elements in contact request permission to bypass Threat force. Detached element watches Threat force while remainder of troop continues zone reconnaissance.			

Figure 6 (Continued)

problems and reliance on tactical participants' skills in location reporting.

The two senior controllers checked the accuracy of the location information provided by the participants. They evolved a system of radio coordination so that each controller knew where all his personnel were and what the tactical effects would be if any element had permission to fire. This communication procedure also gave the two senior controllers a comprehensive picture of what was occurring in the simulated battlefield, which was useful in leading the discussion in the after action review that followed the exercise.

Report data could be corroborated in many instances by their relation to objective data. In the second exercise, for example, conditions were established to create known situations, which served as probes to test reconnaissance capability.

Items of intelligence interest--an abandoned armored personnel carrier, some weapons, and an enemy soldier (represented by a mannequin)--were placed at three known locations, as shown on the map sketch used to brief the observer (Figure 7). Reports from one of the rifle squads early in the exercise indicated that the squad was not where it should have been, and there was no way to be sure of the actual location. However, when the squad reached the abandoned vehicle and correctly reported its REALTRAIN number, it was certain that they had followed the wrong road.

The mannequin "enemy soldier" also enabled observers to record the location of tactical events. The controller recorded the times and places that the platoon leader dismounted to conduct ground reconnaissance. These estimates were verified when the vehicle reached the known location of the mannequin and "took dummy prisoner at 1255." The observational data were thus anchored to a known location. In general, the known locations clarified records of tactical performance.

DISCUSSION

Often in performance assessment situations, there is a strong tendency to measure what is easy to measure. For example, the Army Training Tests, which preceded the current ARTEPs, relied heavily on subjective checklists concerning the planning, coordination, preparation, and movement phases of tactical operations. ARTEPs emphasize the importance of analyzing critical aspects of missions. The major tasks differentiated for each mission in the ARTEP reflect fundamentals of land combat more accurately than did the earlier Army Training Tests. However, extensive training experience with tactical ES has demonstrated that further improvement can be made in selecting training objectives and measuring their attainment.

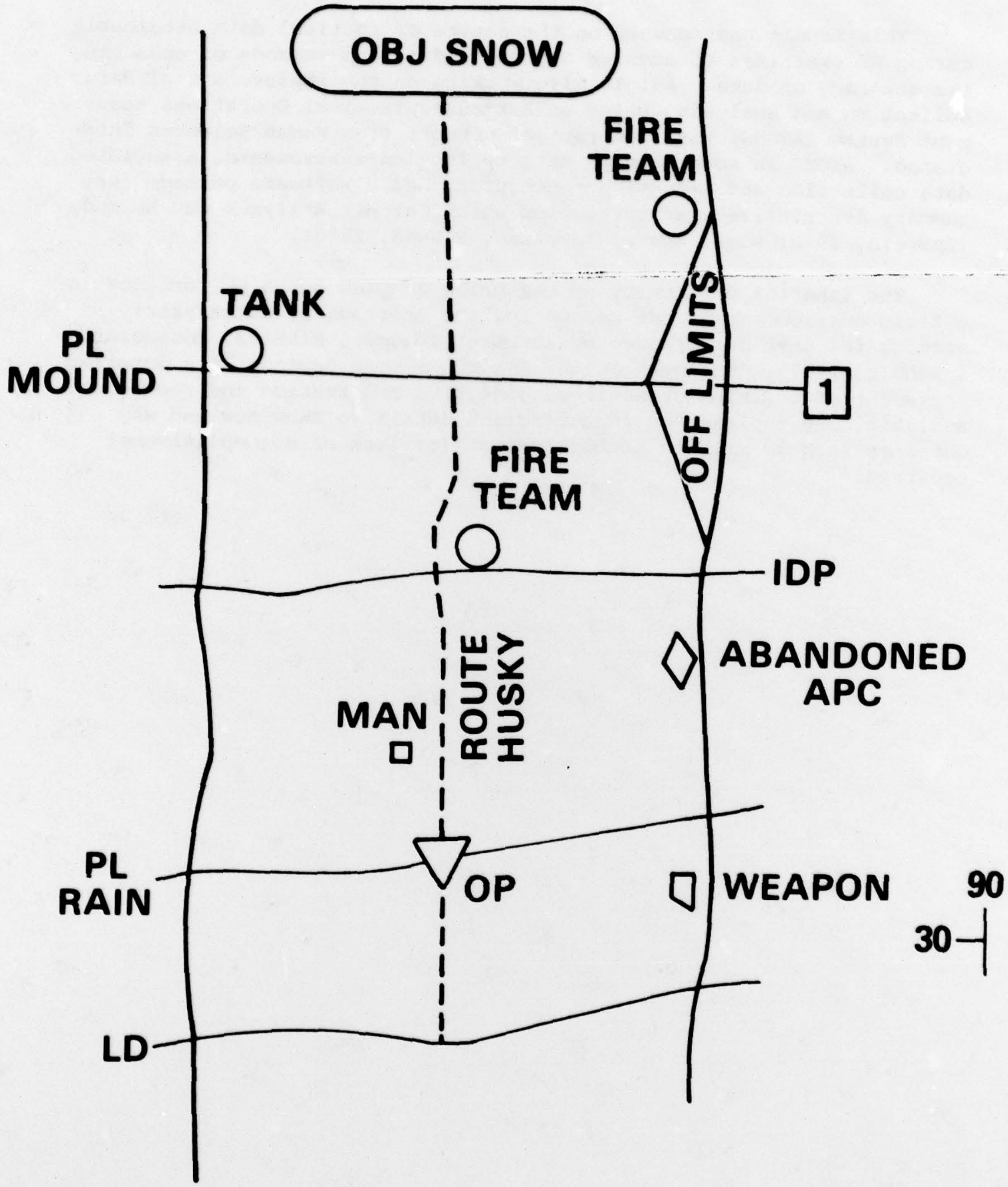

Figure 7. Map Sketch

This report has focused on the nature of tactical data attainable during ES exercises to acquire objective data and methods of enhancing the accuracy of data. ARI is also working on the improvement of data collection and analysis, using an Automated Tactical Operations Measurement System (ATOMS) with contractual support from Human Sciences Integrated. ATOMS is comprised of data collection instruments, associated data collection and reduction procedures, and a software package for summary descriptive statistics from which further analyses may be made (Epstein, 1978; Root, Knerr, Severino, & Word, 1978).

The inherent difficulty of measuring complex human performance in a field environment is one reason for the shortage of satisfactory methods for unit performance measurement (Wagner, Hibbits, Rosenblatt, & Schulz, 1977). The methodology described here depends on a detailed statement of training objectives, objective observation and recording, analysis, and explanation in sufficient detail to show how and why outcomes such as mission accomplishment (or lack of accomplishment) occurred.

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